Monitoring Freshwater Mussels in the Mississippi National River and Recreation Area

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INTRODUCTION

In 2000 and 2001, a survey of the Unionid mussel resources within the Mississippi National River and Recreation Area (MNRRA) was completed by the Minnesota Department of Natural Resources. A mussel community recovering from decades of water quality degradation was documented and recommendations were made in the final project report for long-term monitoring of the mussel fauna. This project addresses these recommendations by adding three quantitative monitoring sites in three of the six reaches listed in the report and expands the data set acquired during the initial study by establishing additional timed searches in the Lower Pool 2 reach.

WORK AREAS AND OBJECTIVES

Kelner and Davis (2002) described and mapped the sites referred to below.

1. Pool 1, Site 46 - collect total substrate quadrat samples.

2. Lower Pool 2 - locate one quantitative monitoring site by conducting two to five reconnaissance dives (timed searches) to assess mussel abundance and species richness. Collect total substrate quadrat samples at one selected site (site 047).

3. Upper Pool 3, Site 131 - collect total substrate quadrat samples.

METHODS

Qualitative samples were collected following the procedures outlined in "Final Report: Mussel (Bivalvia: Unionidae) survey of the Mississippi National River and Recreation Area Corridor, 2000-01" (Kelner and Davis 2002):

"A timed qualitative sample approach at multiple sites along the reach was used in order to relatively quickly locate and delineate a subset of high density and species rich mussel community boundaries. At each site…divers hand collected all live and dead mussels by crawling along the river bottom, continually sweeping hands back and forth sifting through the substrate while looking and feeling for mussels. Divers typically searched all

microhabitats at a particular site with the intent of locating high mussel densities and collecting as many live mussels as possible thus maximizing the chance of collecting all species present. Divers kept track of their depth and position relative to shore and obvious landmarks in relation to mussel densities in order to delineate the high mussel density boundary."

"All mussels collected were placed in mesh bags, brought to the surface, identified as to species, counted, and returned to their approximate collected location. Zebra mussels (*Dreissena polymorpha*) and byssal threads attached to native mussels were also counted and noted, respectively."

"For each site, time spent searching and general habitat conditions (i.e., min. max. depth, substrate [silt/sand/gravel/cobble/boulder], general riparian zone) were recorded. One centrally located GPS coordinate was recorded within each site, which marked the site's general location. If a site appeared to support a species rich and abundant mussel community that included rare species, multiple points along the perimeter of the mussel bed were recorded with GPS. Since the mussel beds were typically close to shore, either on or along sand bars or along slopes just off the river bank, GPS coordinates were only recorded along the riverward, upstream, and downstream boundaries."

Quantitative samples (Miller and Payne 1988) were collected as follows: Using SCUBA, a diver randomly placed a ¼ m^2 metal frame with an attached ¼ in^2 mesh bag on the river bottom within preselected sites. All substrate and mussels within the frame were removed and placed into the mesh bag. Each mesh bag sample was brought to the surface, fine substrates rinsed through the bag, and all live mussels, empty mussel shells and any live zebra mussels removed and placed in a separate bag for analysis. As additional samples were obtained, the boat was moved to spread effort across the mussel bed area predetermined by onsite reconnaissance dives. For each sample, all live mussels were identified, their total length measured, external age rings counted, number of attached zebra mussels recorded, and presence of zebra mussel byssal threads noted. Any other live zebra mussels present in the sample were counted. A minimum of thirty samples was collected from each site; additional samples were collected until no new species were found in the preceding five samples.

RESULTS, ANALYSIS, AND DISCUSSION

Pool 1 study area

Qualitative sampling

One timed search was completed at the site of *Lampsilis higginsii* cage propagation in 2001 (Figure 1). Nineteen mussels representing five species were collected during a 20-minute search of the area (CPUE = 0.95 mussels/minute). No *L. higginsii* or other listed mussel species were found.

Quantitative sampling

Three reconnaissance dives were used to position the dive boat over the mussel bed at site 46 (2001 study) in Pool 1. This site is located along the left descending bank near river mile (RM) 851 (Figure 1) in water 4-8 ft deep. Substrates in the mussel bed are composed of sand and coarse gravel.

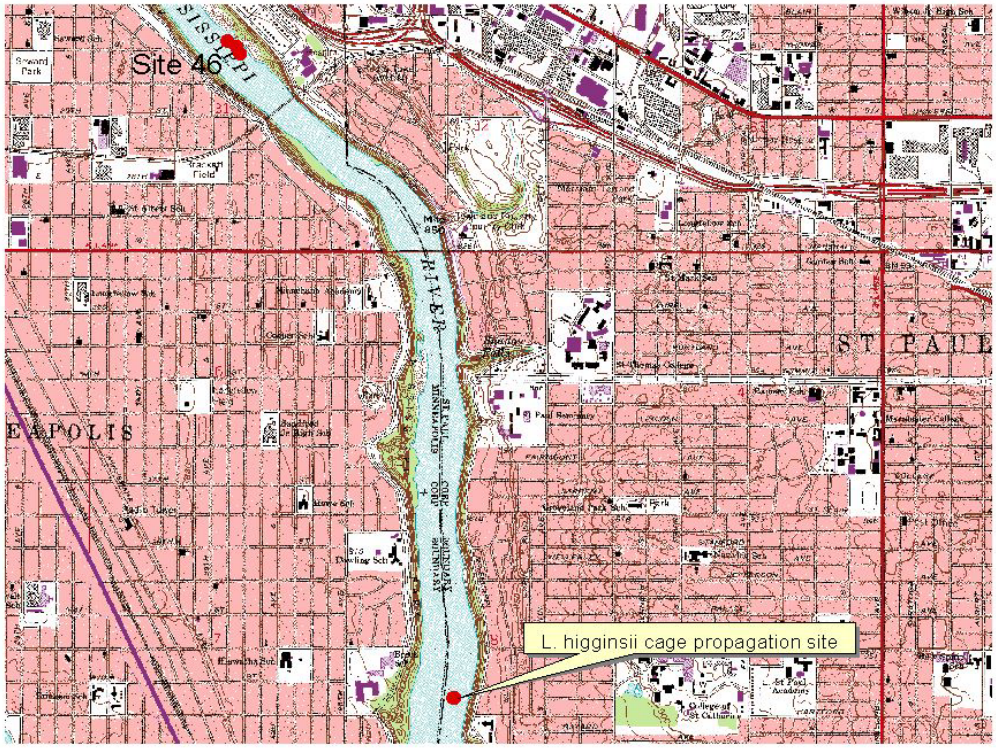

Figure 1. Mississippi National River and Recreation Area, Pool 1 Mussel Monitoring Study Area, 2003.

Thirty-four quadrat samples were collected from site 46. Density measured at this site, 2.6 mussels/m^2, was similar to the density previously measured at a site near Coon Rapids in the Upper St. Anthony Falls Pool, greater than the density previously measured in that pool near Durham Island, and much lower than that previously measured at the next site downstream in Pool 2 (Kelner and Davis 2002). Seven species of Unionids were collected in the quadrat samples, including the MN Endangered *Quadrula nodulata* (Table 1). Two freshwater snails, *Pleurocera acuta*, were also collected in these samples. No zebra mussels or any evidence of their presence (such as old byssal threads attached to shells) were collected from any of the samples in Pool 1.

Table 1. Mississippi National River and Recreation Area Pool 1, site 46 quadrat data (34 quadrats), 2003.

Species	**# Mussels Collected**	**# Individuals/m^2**
Fusconaia flava	7	0.82
Obliquaria reflexa	6	0.71
Quadrula quadrula	2	0.24
Amblema plicata	2	0.24
Truncilla truncata	1	0.12
Quadrula pustulosa	1	0.12
Quadrula nodulata	1	0.12

Mussels at this site were young, 19 of the 22 collected were 10 years old or less. Too few mussels of any given species were collected to allow meaningful analysis of their age frequency distribution, so all species were analyzed collectively (Figure 2).

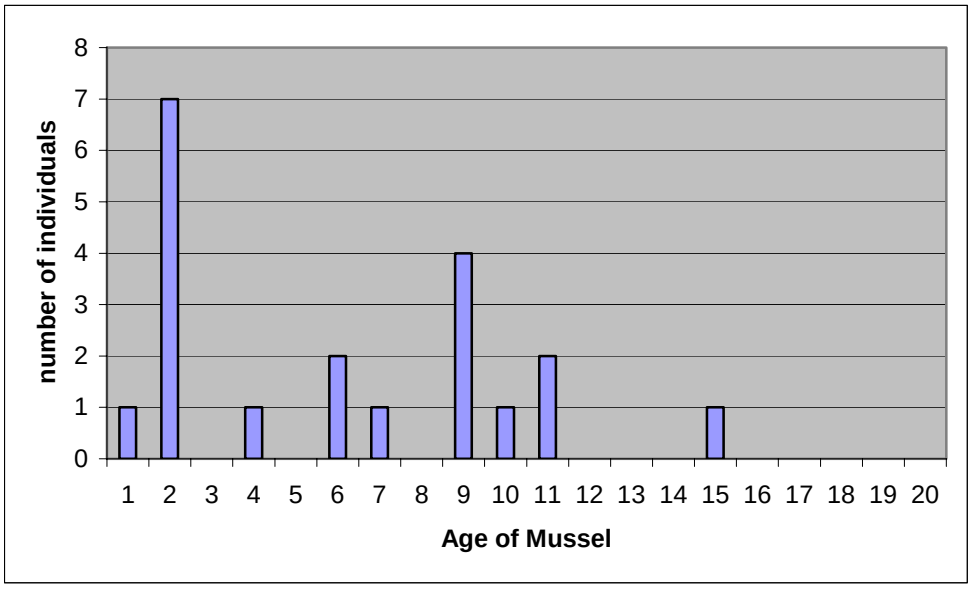

Figure 2. Age frequency of all mussels collected at site 46, Mississippi National River and Recreation Area, 2003.

Lower Pool 2 Study Area

Qualitative sampling

Six timed searches and one recorded reconnaissance search were completed in Lower Pool 2 between RM 818 and Lock and Dam 2 (Figure 3). Altogether, 18 species were collected during qualitative sampling and reconnaissance searches.

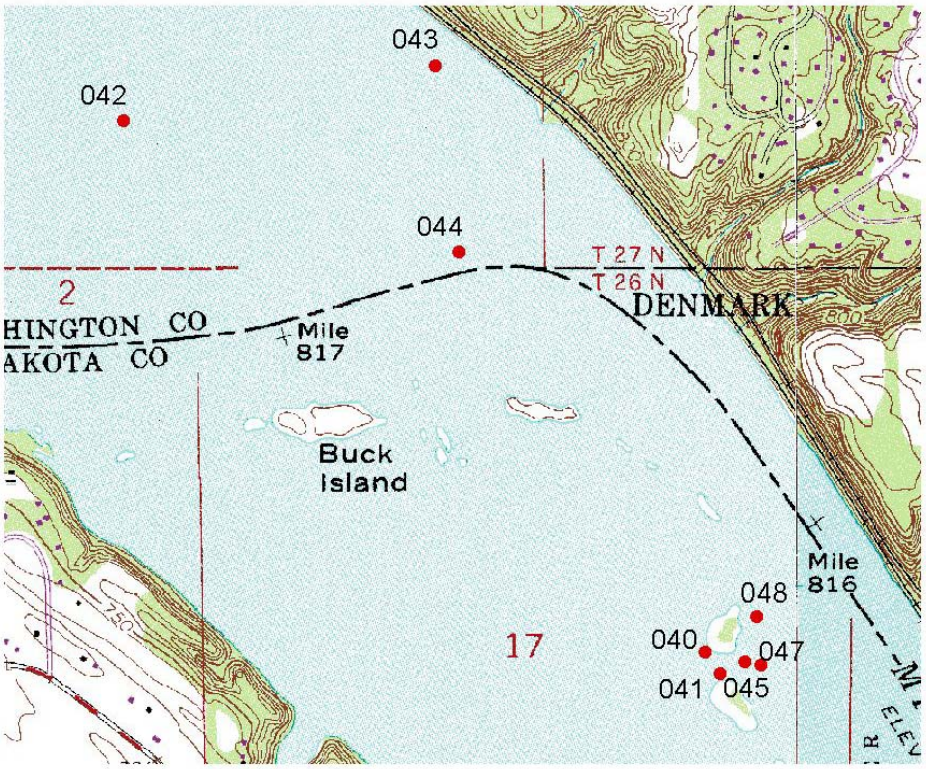

Figure 3. Mississippi National River and Recreation Area, Lower Pool 2 Mussel Monitoring Sites, 2003

Sites 040, 041, 045, and 048 roughly delimit the mussel bed that was sampled quantitatively at site 047. This bed is along two small islands at RM 817. A channel runs between these islands and depths there are greater than the surrounding area. Mussels were most abundant along the upriver slope of the channel and on the shallow, East-facing side of the upstream island. Substrates were sandy at the shallow edge of the channel nearest the island and silty in the channel trough.

CPUE at sites 040, 041, and 045 were 3.6, 2.0, and 3.7 mussels/min, respectively (Table 2). A quantitative sampling site (site 047) was established adjacent to site 045. MN Endangered species *Quadrula nodulata* and *Arcidens confragosus*, and MN Threatened species *Megalonaias nervosa* and *Pleurobema sintoxia* were collected within this mussel

bed. *Megalonaias nervosa*, although historically present in this reach of the Mississippi River, represents a new species record for Pool 2 since sampling began in 2000.

CPUE at sites 042, 043, and 044 were 1.1, 0.5, and 0.2 mussels/min, respectively (Table 2); no clear defined mussel bed was found. MN Endangered species *Quadrula nodulata* and *Arcidens confragosus* were collected at sites 042 and 043. No zebra mussels or any evidence (such as old byssal threads attached to other objects) of their presence were found during the sampling effort.

Table 2. Numbers of live mussels from sites in the Mississippi National River and Recreation Area. 2003 survey results. 'X' in column for site 48 indicates species was found live, no timed search was conducted at this site.

	Site Number							
Species	**40**	**41**	**42**	**43**	**44**	**45**	**48**	**Total # Individuals**
Amblema plicata	3	1		1		4	X	9
Arcidens confragosus	1		1	1			X	3
Fusconaia flava	6	7		1		3	X	17
Lasmigona complanata	1							1
Leptodea fragilis	1				1	1		3
Megalonaias nervosa							X	
Obliquaria reflexa	19	6	4	1		9	X	39
Pleurobema sintoxia	1							1
Potamilus alatus		1	1					2
Potamilus ohiensis			2					2
Pyganodon grandis	4	2	3			1	X	10
Quadrula nodulata			1	2		1	X	4
Quadrula pustulosa	1					2	X	3
Quadrula quadrula	15	12	5	1		16	X	49
Strophitus undulatus							X	
Truncilla truncata	1	1					X	2
Utterbackia imbecillis	1				1			2
CPUE (#mussels/min)	**3.6**	**2**	**3.7**	**1.1**	**0.5**	**0.2**		
Total # Individuals	**54**	**30**	**17**	**7**	**2**	**37**	**NA**	**147**

Quantitative sampling

Thirty-one quadrat samples were collected at site 047. Fifty-five individual mussels representing nine species were collected in quadrat sampling at this site (Table 3). Mussel density of all species was measured to be 7.1 mussels/m^2.

Quantitative sampling of Lower Pool 2 in 2001, near Grey Cloud Island, measured the density of mussels present there to be 9.8/m^2, slightly higher than at site 047 in 2003. *Obliquaria reflexa* was the most abundant species at this site.

Table 3. Quantitative results of mussel sampling (31 quadrats) in Lower Pool 2, site 047, Mississippi National River and Recreation Area, 2003.

Species	# Mussels Collected	# Individuals/m2
Obliquaria reflexa	18	2.32
Quadrula quadrula	13	1.68
Amblema plicata	7	0.9
Fusconaia flava	6	0.77
Truncilla truncata	4	0.52
Pyganodon grandis	2	0.26
Quadrula nodulata	2	0.26
Quadrula pustulosa	2	0.26
Utterbackia imbecillis	1	0.13

The population of *Obliquaria reflexa* collected at site 047 indicates that strong recruitment of this species is occurring at this site and that it is a population mostly less than ten years old (Figure 4). *Quadrula quadrula* on the other hand is recruiting new individuals to its population at a much lower rate and is dominated by individuals more than seven years of age (Figure 5).

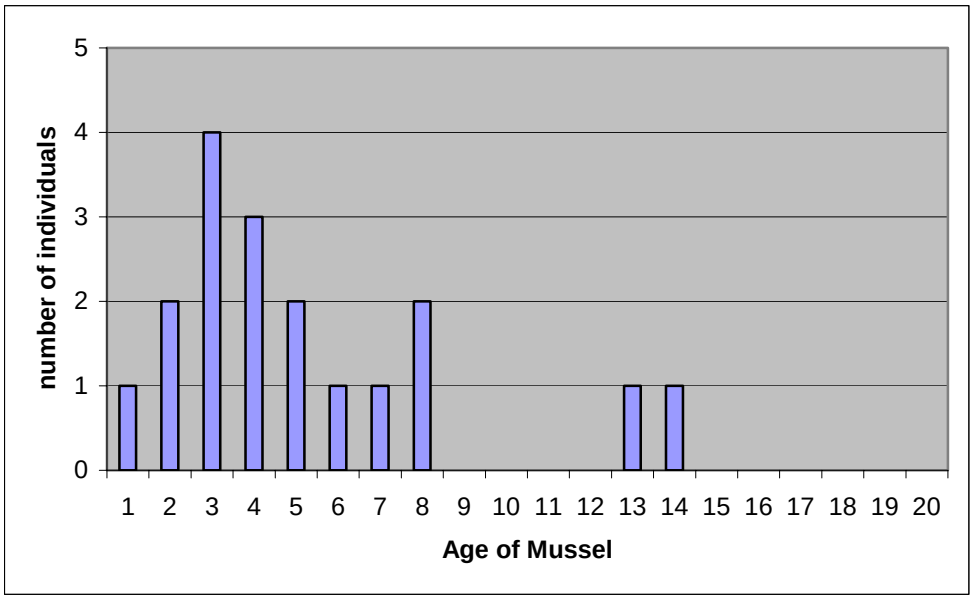

Figure 4. Age frequency distribution of *Obliquaria reflexa* at site 047, Mississippi National River and Recreation Area, 2003.

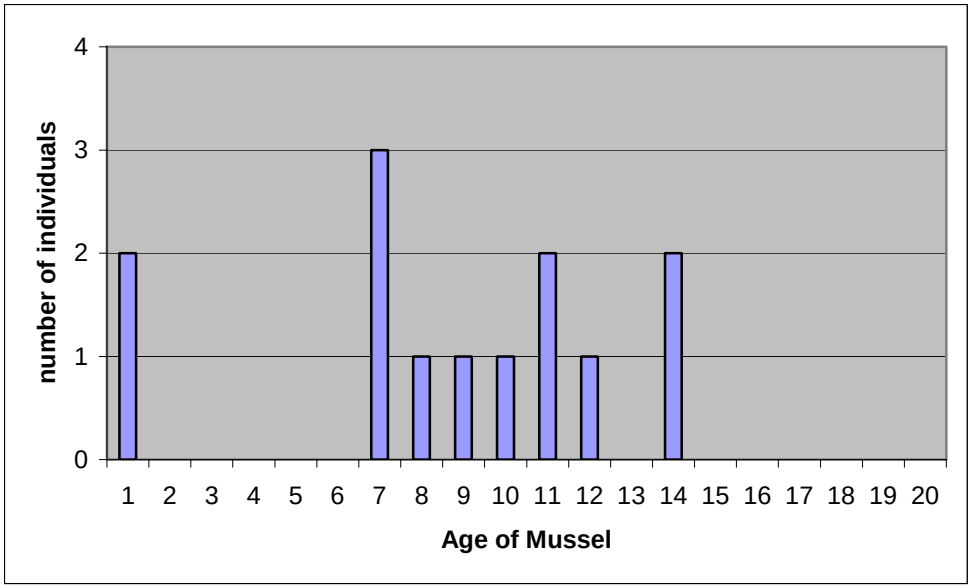

Figure 5. Age frequency distribution of *Quadrula quadrula* at site 047, Mississippi National River and Recreation Area, 2003.

Overall, the mussel population at this site is young and is recruiting new individuals (Figure 6). No mussels over the age of 17 were found and only 13 of the 55 individuals collected during sampling were over age 10.

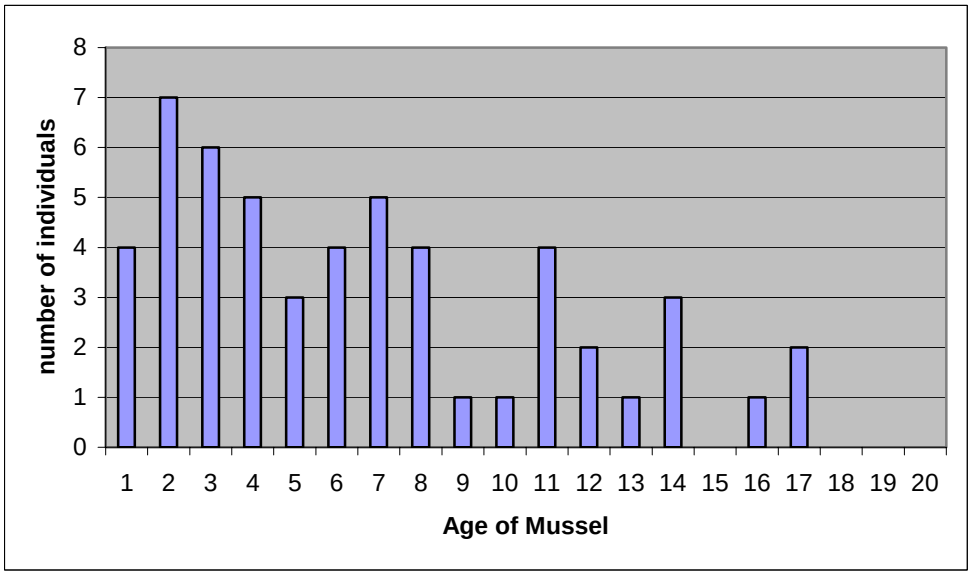

Figure 6. Age frequency distribution of all mussels collected at site 047, Mississippi National River and Recreation Area, 2003.

Upper Pool 3 Study Area

Quantitative sampling

MNRRA site 131 (Figure 7) is located along the left descending bank of the Mississippi River just downstream of Prescott, WI, at RM 810.4. This site encompasses an area bounded on the navigation channel side by a sand bar less than 3 ft deep at normal pool level and the Wisconsin shore. Sample depths range from 3 - 8 ft, substrate varies from sand on the navigation channel side, silty clay in the deepest areas and gravel along the Wisconsin shoreline.

Thirty-three quadrats were collected at MNRRA site 131. Fifty-four individual mussels representing 8 species were found in these samples; measured density of mussels was 6.55 mussels/m^2 (Table 4). Unlike the upstream quantitative sites, *Amblema plicata* was the most abundant mussel species.

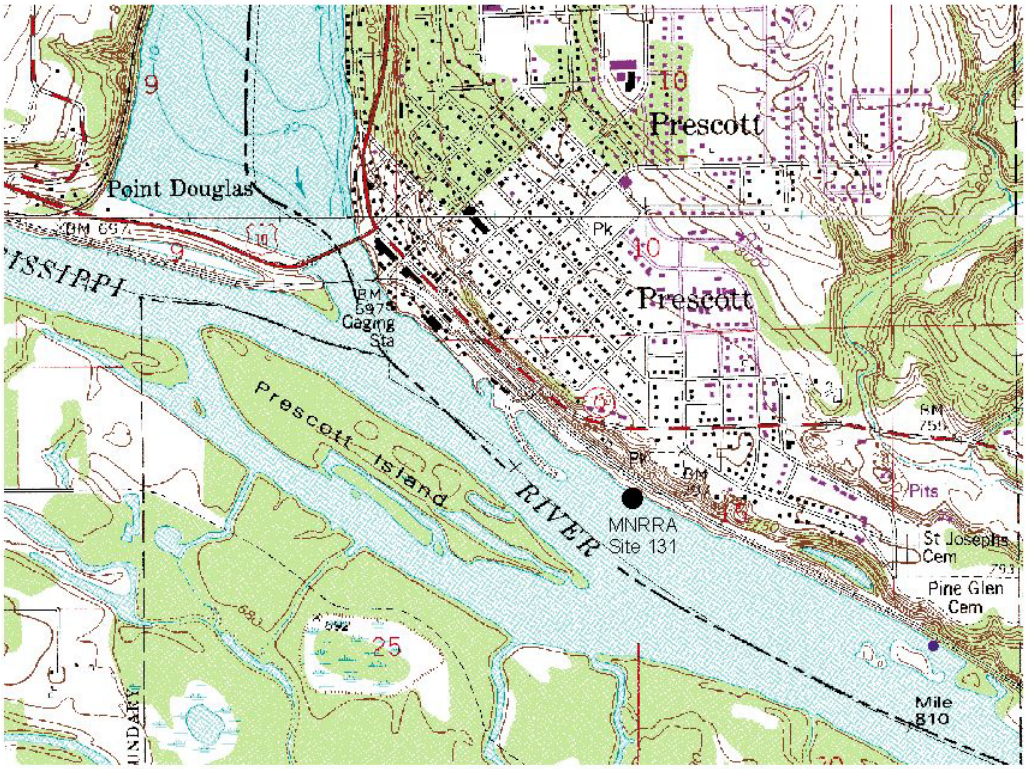

Figure 7. Mississippi National River and Recreation Area, Upper Pool 3 Mussel Monitoring Study Area, 2003

Table 4. Quantitative results of mussel sampling (33 quadrats) in Pool 3, site 131, Mississippi National River and Recreation Area, 2003.

Species	**# Mussels Collected**	**# Individuals/m2**
Amblema plicata	28	3.39
Fusconaia flava	11	1.33
Obliquaria reflexa	8	0.97
Quadrula pustulosa	3	0.36
Lasmigona complanata	1	0.12
Lampsilis cardium	1	0.12
Potamilus ohiensis	1	0.12
Quadrula quadrula	1	0.12
Total	**54**	**6.55**

Mussel age at this site was greater than at the Pool 1 and Pool 2 sites (Figure 8) with many mussels older than 10 yrs present. However, the presence of younger individuals indicates that recruitment was also occurring. Older individuals dominate the *Amblema plicata* population, and the small number of animals less than 10 years old indicates low recruitment rate of this species (Figure 9).

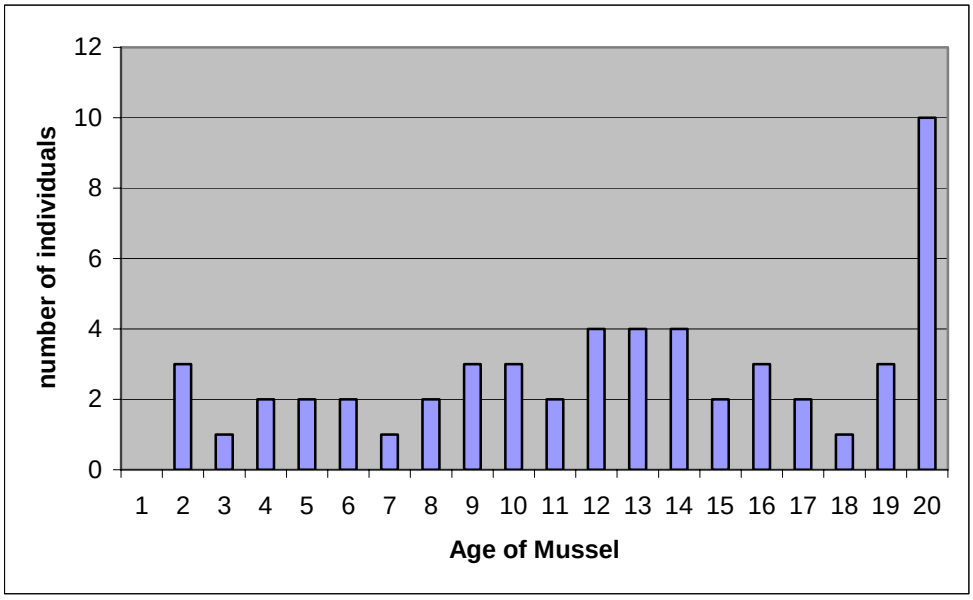

Figure 8. Age frequency distribution of all mussels collected at site 131, Mississippi National River and Recreation Area, 2003.

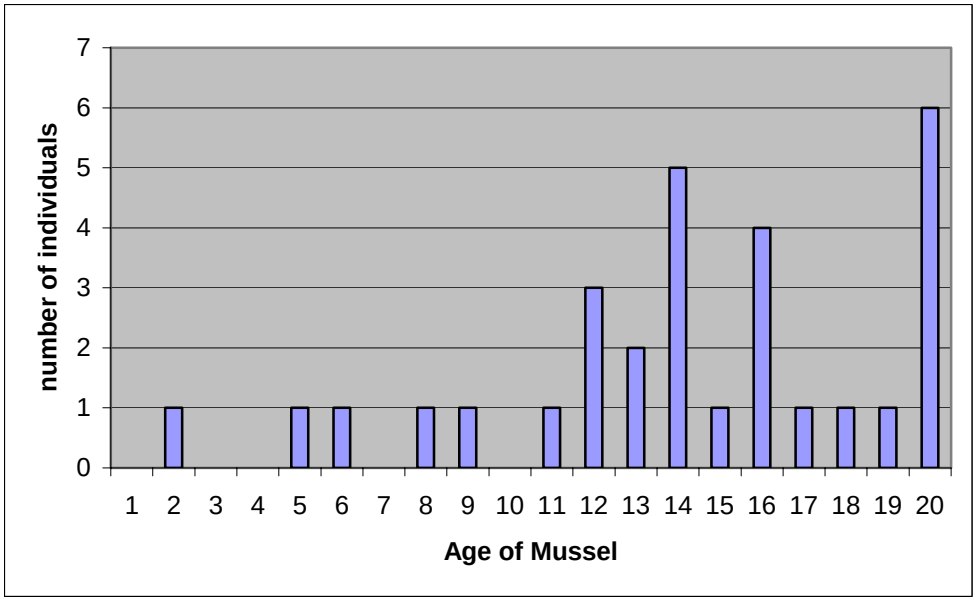

Figure 9. Age frequency distribution of *Amblema plicata* at site 131, Mississippi National River and Recreation Area, 2003.

Older individuals also dominate populations of *Fusconaia flava* (Figure 10). A few young individuals of this species are present, indicating some recent recruitment. Many year classes were absent from the sample.

Figure 10. Age frequency distribution of *Fusconaia flava* at site 131, Mississippi National River and Recreation Area, 2003.

No zebra mussels were collected in any of the quadrats at site 131, and none of the native mussels had any old byssal threads attached, an unexpected finding given the proximity to the zebra mussels colonizing the Lower St. Croix River in the Prescott, Wisconsin area.

CONCLUSIONS

Three additional quantitative mussel survey sites were established in 2003 in the MNRRA corridor Pools 1, 2 and 3. One new mussel bed was discovered in Lower Pool 2 that is of high quality and density. This study effort has successfully fulfilled 4 of the 13 recommendations included in the earlier MNRRA mussel report (Kelner and Davis 2002). The data collected during the 2003 study confirms the ongoing recovery of the mussel fauna in Pools 1 and 2, an area that as recently as 1978 was considered to be virtually uninhabited by native mussels (Fuller 1980). In Pool 3 at site 131, the mussel population is clearly composed of older individuals and dominated by different species than the beds upstream in Pools 1 and 2. This suggests that this bed may have existed at the time Fuller (1980) made the observation on Pools 1 and 2. Flow of high quality water from the St. Croix River less than one mile upstream may have protected this mussel bed from some of the water quality insults that affected the river above the mouth of the St. Croix River.

Pool 2 today supports Minnesota's largest known populations of state Endangered *Quadrula nodulata* and *Arcidens confragosus*. This study confirms that both species are continuing to recruit new individuals to their populations.

RECOMENDATIONS

In 2004, the implementation of the recommendations found in Kelner and Davis (2002) should continue. High priority should be given to establishing a quantitative site upstream of the mouth of the St Croix River to better define the differences in the mussel community and species populations between Pools 2 and 3 and the influence of the St. Croix River on mussel fauna. Establishing a quantitative mussel-monitoring site here would also contribute to determining whether or not the transplanted federally Endangered *Lampsilis higginsii* in this area are recruiting young mussels into this part of the river.

LITERATURE CITED

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